

STUDENT ACHIEVEMENT IN
ELECTROMECHANICAL
TECHNOLOGY

By

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CHAPTER I

INTRODUCTION

As science and technology becomes more advanced it will be necessary for the individual man to become increasingly specialized in his occupational pursuit. Technician education deals with the application of physical science at the level between engineering on the one hand and the skilled trades on the other. In many respects it is little different from other educational areas. Almost all areas of education have become interested in identifying potential students who possess those abilities which promise success.

There have been relatively few studies which deal with the specific problem of how to identify promising students for technician education; furthermore, there is some evidence that these students demonstrate different characteristics than do university students.

Statement of the Problem

In recent years there has been a rapid growth of technology that has generated a need for technicians in such areas as electronics, electromechanical, electro-optical and industrial drafting and design technology. For this reason it would seem appropriate at this time to start developing

methods for identifying promising students in these and other areas of technology.

Purpose of the Study

The general purpose of this study was to establish a basis from which promising students for technologies could be identified. Specifically, the purpose of this study was to investigate whether or not the factors (American College Test and Grade Point Average) which are appropriate for identifying promising potential students for the emerging technologies are the same ones that are appropriate in other areas of education.

Assumptions and Variables

The following assumptions and variables were used in the study.

1. The grading system used by each instructor was assumed to be fundamentally the same, so that achievement could be measured by the conventional course grade system. (A is given a numerical value of four, B a value of three, C a value of two, D a value of one, and F a value of zero.)
2. A high positive correlation between American College Test scores and Grade Point Average was assumed to indicate that the (ACT) scores could be used as predictors of success in technology programs.

3. The students involved in the study were assumed to be of representative of future enrollees.
4. It was assumed that all of the data could be considered to be at least ordinal in nature.
5. Each student's (ACT) composite score and (ACT) mathematics score were selected as independent variables.

Definition

For the purpose of this study the following functional definition is useful:

Achievement in the study of technology is understood to be defined in terms of Grade Point Average (GPA). That is, a student's achievement score is numerically equal to his grade point average.

Statement of the Hypotheses

Based on a review of the literature and the scope of this study, the following hypotheses could be stated.

1. There is no statistically significant correlation between the American College Test (ACT) mathematics score and the math-and-science Grade Point Average (GPA) earned at Oscar Rose Junior College.
2. There is no statistically significant correlation between the (ACT) composite and the General Education (GPA) scores earned at Oscar Rose Junior College.

3. There is no statistically significant correlation between the (ACT) composite and the cumulative (GPA) earned at Oscar Rose Junior College.
4. There is no statistically significant correlation between the (ACT) math score and the (GPA) earned in technical courses in the electromechanical technology program at Oscar Rose Junior College.
5. There is no statistically significant correlation between the (ACT) composite score and the (GPA) earned in technical courses in the electromechanical technology program at Oscar Rose Junior College.

CHAPTER II

REVIEW OF LITERATURE

In a review of the literature relating to the establishment of a basis from which promising students for the technologies can be identified, several studies are to be found. In the following pages a number of typical studies are discussed.

Van Derslice (29) divided technical education student characteristics into three categories: Educational, psychological, and sociological.

He identified the educational characteristics of a high school graduate, average age 19, as being above the national average in educational ability and achievement. The average technical education student had a 2.0 or "C" average in high school and had two years in high school mathematics (algebra and geometry). This student was below the level of the four year college student as measured in mathematics and in science but did well above average in the ability to handle applied theory.

Using the School College Aptitude Test (SCAT) Van Derslice found that technical students scored at about the 45th percentile on verbal comprehension, near the 47th percentile on quantitative or abstract reasoning, and at about

the 40th percentile on a reading comprehension test. He concluded that technical students must possess abilities in verbal comprehension, numerical reasoning and numerical ability.

Garrett (12) in his review of predictive studies for estimating success in college cites several hundred such studies. High school grade point achievement tests, intelligence measures, aptitude tests, interest, character and personality measures had been the most common variables studied in relation to predicting college achievement.

Others have used age, background data, and non-cognitive factors, but so far with less success than with the more widely used cognitive factors. The weight of evidence from studies reported in the literature to date, would place high school scholastic achievement or rank at the top of the list in terms of the best single predictor of college scholastic success.

Garrett drew the conclusion after reviewing several hundred studies that the following four factors had the highest predictive values for college achievement:

1. High school grade point, median R or 0.56.
2. General achievement test scores, median R of 0.49.
3. Intelligence test scores, median R of 0.47.
4. General college aptitude test scores, median R of 0.43.

One of Garrett's (12) conclusions was:

There is a closer correlation between intelligence test scores and later college grades for those scoring high in intelligence than for those scoring average or low in intelligence. This would indicate that students with high intelligence tend to succeed in college in spite of all other factors operating. With students of lesser mental ability, however, some may put other factors into operation to bring them scholastic success, and some may not. This uncertainty makes it more difficult to predict scholastic success in college for this group (p. 138).

Schroeder and Sledge (24) did a comprehensive review of studies from 1950 seeking factors relating to collegiate academic success. The authors said that:

Intellective factors were found to be more predictive of collegiate achievement than non-intellective factors although the importance of the latter was not disrupted. Intellective factors found in decreasing order of importance were high school achievement (grade point average slightly superior to rank in class), subject matter test scores, and measures of mental ability...grades specific high school courses seemed to correlate more highly with similar college course grades than overall collegiate grades (p. 103).

Greenwood (15) in an effort to predict the success of some New York state engineering technology students concluded:

1. Intelligence test scores, high school mathematics and English averages, and the number of years of high school mathematics are likely to be related to academic success in the technical curriculums of community colleges.
2. It was desirable for students entering electrical or mechanical curriculums to have had at least three years of high

school mathematics, although some students are successful with less (p. 23).

Brown (6) in a study of technical institute students at Oklahoma State University stated that out of 70 students considered in this research, 29 were found to be successful and 41 were considered unsuccessful.

The results show that mechanical reasoning by itself could be used as a predictor of success at the five percent level, but since spatial relations resulted in not only a relatively poor correlation with grade point average but also a relatively low value of it, it has a nullifying effect when used in combination with mechanical ability. Thus a composite of the two cannot be used as a predictor of success of technical institute students.

Brown found that the results of the mathematics (ACT) test proved to be confusing since a negative correlation with respect to grade point average was obtained. Yet the test of significance permitted rejection of the null hypothesis at the one tenth of one percent level (0.1%), thus showing a significant difference between mathematics test scores of the successful students versus the unsuccessful students.

Of all tests and combination of tests given, the composite of the (ACT) tests resulted in the highest correlation with grade point average ($R = 0.410$), and the result of the t-test was sufficiently high for rejection of the null hypothesis at the one percent level. The composite of the (ACT) test, then could be used as a predictor of success.

Tinnell (27) took the first step toward establishing a basis from which promising students for the emerging technologies could be identified. He studied 22 students of the Oklahoma State University Electromechanical Pilot Training Program.

In the study, the Kendall rank correlation coefficients representing the relationships between the (ACT) mathematics scores, (ACT) composite scores, as well as the General Aptitude Test Battery (GATB) Learning Ability scores and student achievement in electromechanical technology were well below 0.1 and were not statistically significant.

Tinnell's observed coefficient of correlation for the relationship between General Aptitude Test Battery (GATB) numerical scores and achievement in electromechanical technology was 0.252. The level of statistical significance of this correlation was 0.50.

In the case of the cooperative mathematics algebra test, the test scores correlated with achievement in electromechanical technology to the extent of producing a Kendall rank correlation coefficient of 0.361 at the 0.011 confidence level. The Kendall rank correlation coefficient for the relationship between high school mathematics background and achievement in electromechanical technology was the highest revealed by the study. The coefficient value of 0.600 was significant to the 0.00005 level.

From the results, Tinnell concluded that high school background in mathematics offered the most promise for

identifying potentially successful students for electro-mechanical technology.

The various authors used several methods of examining the data they had collected. Brown (6) used Spearman's Rho and the t-test of significance, developed by R.A. Fisher. Chin (7) and McClain (21) used the Pearson product-moment coefficient of correlation and Fisher t-test, except that McClain also used the Fisher z-transformation.

Summary

High school grades, intelligence tests, scholastic aptitude tests, and ability tests have been considered as useful predictors of success of students in college. Evidence seems to show that high school grades correlate with success about as well as any other variable examined.

CHAPTER III

METHODOLOGY

In this chapter the methodology used in investigating the problem of this study is given. The selection of the subjects, the procedure followed, and the treatment of the data are also discussed. All grades used in determining achievement were obtained from the student's official file. The students who had finished two technical mathematics courses, and had graduated from the electromechanical technology program were selected as subjects. Electro-mechanical majors who had not taken two mathematics courses were not used in this study.

Table II in Chapter IV presents the data relative to the (ACT) scores, math-and-science (GPA), general education (GPA), technical courses (GPA) and cumulative grade point average (GPA) for each student. Letter grades earned by students were converted to a numerical scale ranging from zero for "F" to four for "A". Grade point averages were computed by multiplying the numerical grade by the number of credit hours and taking the mean of the sum of these products.

The predictor variables employed in this study are the (ACT) scores. By comparing these test scores to the grade

point averages the testing of the hypotheses can be accomplished.

Statistical Procedures

There are a variety of ways in which the statistical significance of the five null hypotheses could have been tested. The Pearson product moment method of correlation coupled with the Fisher t-test and z-transformation have been widely used in studies of this type. However, some of the variables used might not constitute an interval scale. Since they are probably at least ordinal in nature, they can be correlated with the dependent variables on a rank basis.

The Kendall rank correlation coefficient, (T), can be used effectively with ordinal measures (25). Establishing the level of statistical significance for the Kendall rank correlation coefficient may be readily accomplished using the familiar z-test.

Because it is desirable to be able to compare results of one hypotheses with those of the others, the Kendall rank correlation coefficient and z-test were used for all of the hypotheses in this study.

The first task was that of constructing a correlation table. The scores used in computing T and z are shown in Table II in Chapter IV. The various courses were grouped in the categories; math-and-science, technical, and general education on the basis of their course number prefix specified by Oscar Rose Junior College on the student's transcript.

No attempt was made to examine individual course content.

Subjects

Many studies have been conducted at the engineering level that would seem to indicate that mathematics abilities are one of the important factors contributing to student achievement.

One of the specific problems, as regards this study, was to examine the strength of the relationship between mathematics and student achievement in electromechanical technology at Oscar Rose Junior College.

The admission data to be considered was gathered from the group of 30 students who had entered the electromechanical technology program at Oscar Rose Junior College. Sixteen of the students were finally selected to be the subjects of the study. In selecting the subjects the criteria was that the students must have graduated from the program.

Data Collection

The American College Test (ACT) scores and Grade Point Averages (GPA) were obtained from the student's official file.

Analysis of Data

The data in Table II were then analyzed using the following six steps:

Step I

(ACT) math scores were grouped into class intervals and entered on they Y-axis.

TABLE I
CORRELATION TABLE FOR (ACT) MATH SCORES
AND CUMULATIVE (GPA)

		X: Grade Point Average							
		2.0	2.4	2.7	3.0	3.3	3.6	3.9	4.0
Y: (ACT) Math Scores	24-26								
	21-23				1	2	2		
	18-20		1		1			1	
	15-17					2	1	1	1
	12-14			2					
	9-11			1					
	6-8								

Then the grade point averages were grouped into class intervals and entered on the X-axis.

Step II

The number of subjects for each pair of scores was placed in the appropriate space in Table I.

Step III

The standard deviation was computed using the formula:

$$K = \frac{2 (2n + 5)}{9n (n - 1)}$$

n = number of ranks

Step IV

Then Kendall's rank correlation coefficient was calculated.

$$T = \frac{X}{\sqrt{0.5N(N-1) - B_A} \sqrt{0.5N(N-1) - B_S}}$$

X = Total score calculated for the ranks of the dependent variable by selecting each in turn, adding one for each larger rank to its right and subtracting one for each smaller rank to its right.

B_S = Dependent variable

B_A = Independent variable

Step V

The significance level was then calculated:

$$z = \frac{T}{K}$$

The results of these calculations are given in Table III. The disposition of each of the hypotheses is also given in Table III.

If a given correlation in this study was statistically significant at the one percent level ($z \geq 7.326$) then that null hypotheses was rejected.

If the correlation coefficient was significant at the five percent level ($z \geq 1.645$) but not at the one percent level then that null hypotheses was or was not rejected depending on the value of the correlation coefficient and the significance level.

If the correlation coefficient was not significant at the five percent level ($z < 1.645$) then that null hypothesis was not rejected.

Step VI

A scatter diagram of each correlation was plotted to assist in gaining insight into the value of the correlation for predicting probable student achievement.

CHAPTER IV

RESULTS

Thirty freshman students were admitted to the electro-mechanical technology program at Oscar Rose Junior College in 1970. Of these thirty students, only 16 students graduated and only those who graduated were used as the subjects of this study. At the end of two years the cumulative (GPA) for each of the students was compiled. In addition, the (ACT) mathematics and composite for each student was determined from official college transcripts. These data, for the 16 students who completed the program, are shown in Table I.

From these data the standard deviation (K), Kendall rank correlation coefficient (T), and the significance level z-score (z) was determined for each of the independent variables (B_A) paired with the dependent variable (B_S).

The level of significance was then determined for each correlation using a z-test table.

The results of these calculations are given as follows:

1. American College Test (ACT) mathematics and Grade Point Average (GPA) math-and-science were $T = 0.23$, $K = 0.034$, $z = 6.84$ and significance level = 0.117.
2. (ACT) composite and (GPA) general education were

$T = -0.098$, $K = 0.034$, $z = 2.88$ and significance level = -0.0188 .

3. (ACT) composite and (GPA) cumulative were $T = 0.007$, $K = 0.034$, and $z = 0.205$ and significance level = 0.401 .

4. (ACT) math and (GPA) technical courses were $T = 0.406$, $K = 0.034$, $z = 3.4$ and significance level = 0.0083 .

5. (ACT) composite and (GPA) technical courses were $T = 0.115$, $K = 0.034$, $z = 11.9$ and significance level = 0.0009 .

A given null hypothesis was rejected if the significance level was equal to or less than 0.01 . If the significance level was over 0.05 for a given hypothesis, it was not rejected. Between the significance levels of 0.01 and 0.05 (including 0.05) a given hypothesis was either rejected or not rejected depending on the strength of the correlation coefficient (T) and on the significance level. The hypotheses tested were:

1. There is no statistically significant correlation between the American College Testing (ACT) mathematics score and the math-and-science Grade Point Average (GPA) earned at Oscar Rose Junior College.
2. There is no statistically significant correlation between the (ACT) composite and the general education (GPA) scores earned at Oscar Rose Junior College.

TABLE II
DATA COLLECTED FROM OSCAR ROSE
JUNIOR COLLEGE

Student	American College Test		Grade Point Average*			
	Math.	Comp.	Math-and- Science	Technical Courses	General Education	Cumulative
1	21	17	3.741	3.75	2.833	3.579
2	17	15	3.3	3.64	3.4	3.477
3	20	18	3.0	3.23	3.0	2.954
4	18	20	4.0	3.84	3.0	3.822
5	12	19	2.0	3.2	2.167	2.743
6	23	26	3.0	3.2	3.0	3.074
7	10	11	1.5	2.0	3.0	2.648
8	18	16	2.0	2.83	2.333	2.403
9	16	16	3.667	3.6	4.0	3.710
10	16	17	3.0	3.46	2.6	3.304
11	14	21	2.667	2.89	2.5	2.731
12	16	18	4.0	4.0	3.8	3.948
13	21	20	3.4	4.0	3.4	3.471
14	16	15	3.75	3.8	4.0	3.828
15	21	21	3.142	3.75	2.833	3.402
16	21	17	4.0	4.0	2.667	3.556

*Based on 4.0 system

3. There is no statistically significant correlation between the (ACT) composite and the cumulative (GPA) earned at Oscar Rose Junior College.
4. There is no statistically significant correlation between the (ACT) math score and the (GPA) earned in technical courses in the electromechanical technology program at Oscar Rose Junior College.
5. There is no statistically significant correlation between the (ACT) composite score and the (GPA) earned in technical courses in the electromechanical technology program at Oscar Rose Junior College.

TABLE III
CORRELATION WITH THE DEPENDENT VARIABLE,
SIGNIFICANCE, AND HYPOTHESIS
DISPOSITION

Variable	T	K	z	Signif. Level	Hypothesis Disposition
(ACT) Math and (GPA) Math and Science	0.23	0.034	6.84	0.117	Not Rejected
(ACT) Comp and (GPA) Gen. Ed.	-0.098	0.034	2.88	-0.0188	Not Rejected
(ACT) Comp and (GPA) Cum.	0.007	0.034	0.205	0.401	Not Rejected
(ACT) Math and (GPA) Tech Courses	0.406	0.034	3.4	0.0083	Rejected
(ACT) Comp and (GPA) Tech Courses	0.115	0.034	11.9	0.0009	Rejected

While correlation coefficients and significance levels are invaluable for determining whether or not a null hypothesis may be rejected, they provide only limited insight into the usefulness of the variables in selecting promising students. For this reason the data of this study are also presented in the form of scatter (or correlation) diagrams. Figures 1 through 5 are the diagrams of the results.

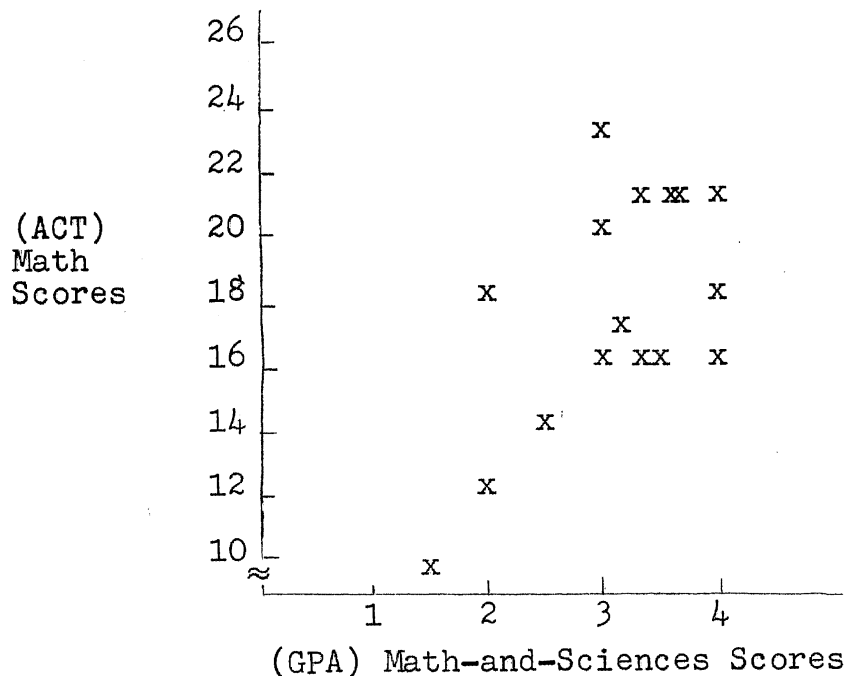


Figure 1. (ACT) Mathematics Scores Vs. (GPA) of Math and Science

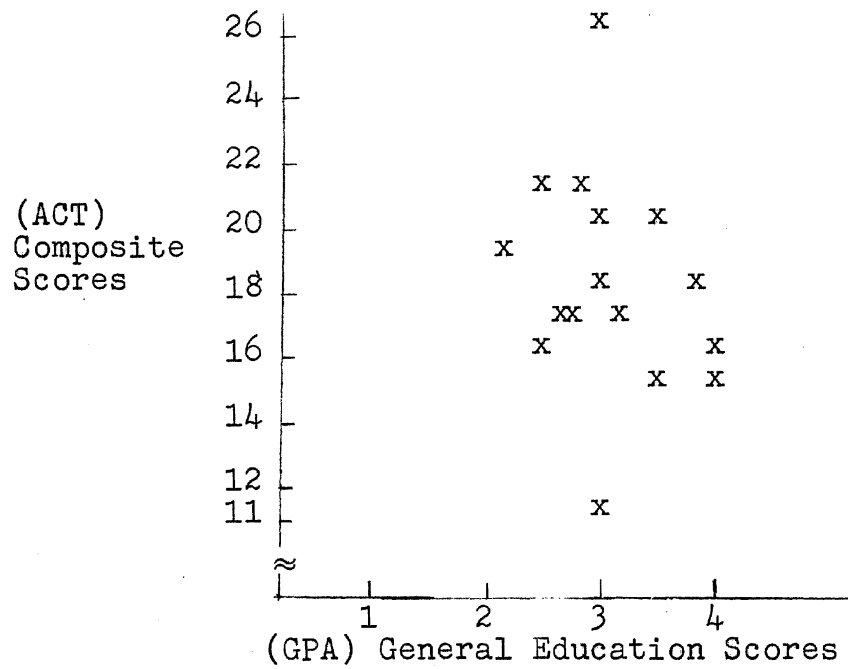


Figure 2. (ACT) Composite Scores vs. (GPA) of General Education Scores

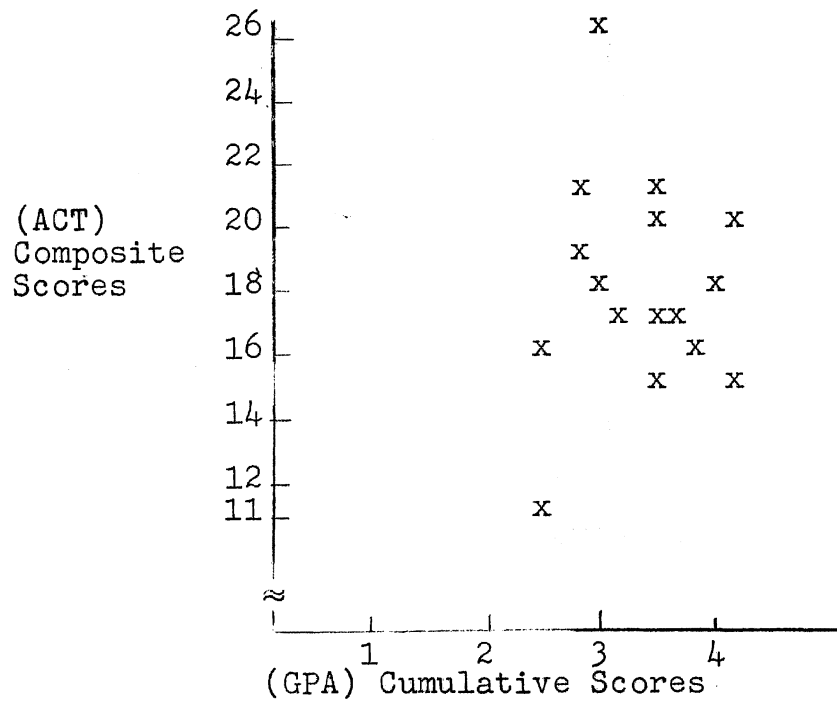


Figure 3. (ACT) Composite Scores vs. Cumulative (GPA)

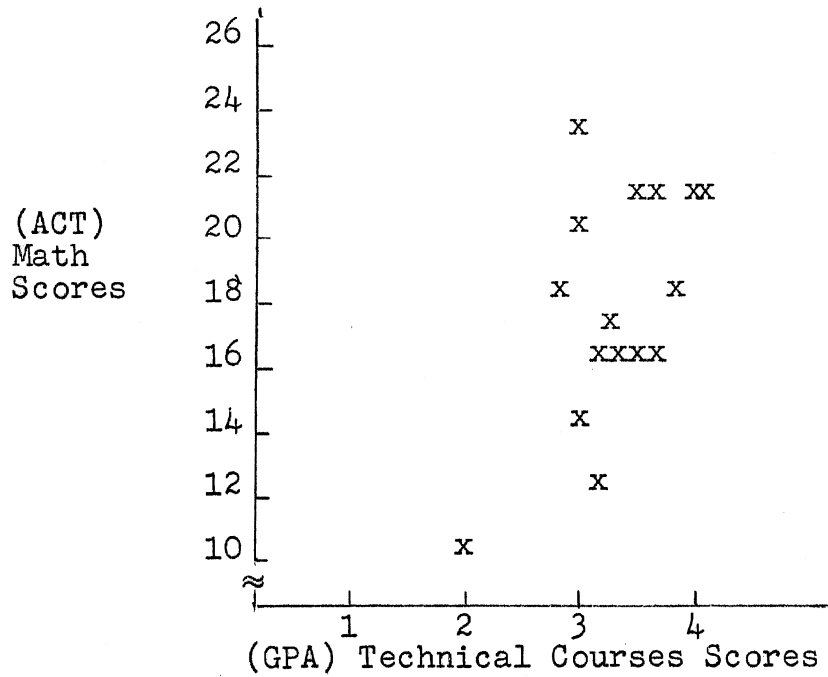


Figure 4. (ACT) Mathematics Scores Vs. Technical Courses (GPA) Scores

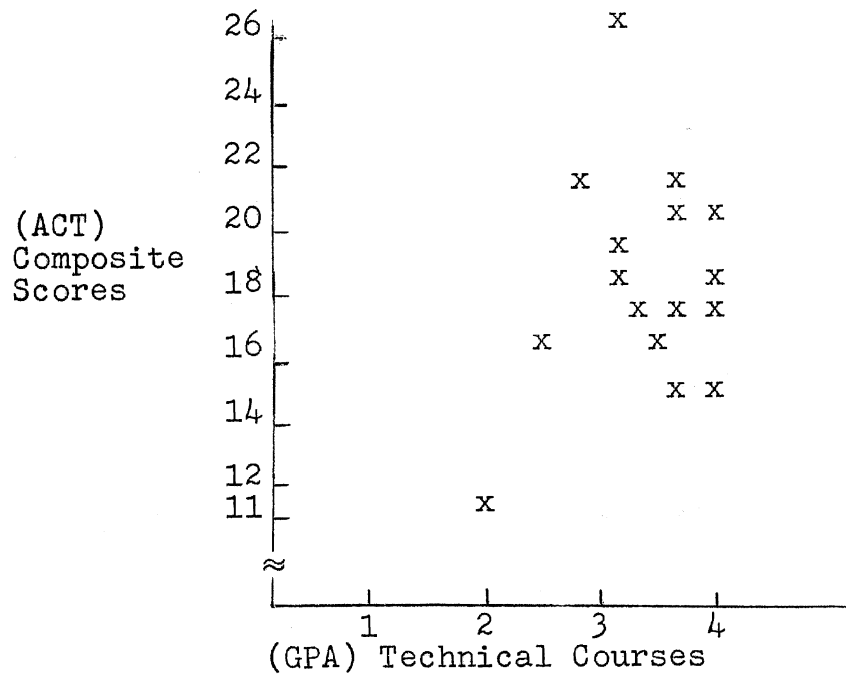


Figure 5. (ACT) Composite Scores Vs. Technical Courses (GPA) Scores

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Of 30 students who entered the electromechanical technology program at Oscar Rose Junior College in 1970, only 16 completed it. The grade point averages of these students were determined and were used as the dependent variables in this study.

Prior to (or immediately after) admission to the program the following data were collected for each student:

1. The (ACT) mathematics score.
2. The (ACT) composite score.

These quantities were the independent variables in the study.

The statistic used in examining correlations between the independent variables and the dependent variables was the Kendall rank correlation coefficient.

The confidence levels of the various coefficients of correlation were determined using a table of the probabilities associated with values as extreme as the observed values in a normal distribution. This procedure is commonly referred to as the z-test for statistical significance.

In abbreviated form the results of the study were:

1. Both the mathematics and composite (ACT) scores were found to be insignificantly correlated with math-and-science (GPA), general education(GPA) and cumulative (GPA) for students in electromechanical technology.
2. The (ACT) composite score and the technical courses (GPA) scores were found to have statistically significant correlations for students in electromechanical technology, but the correlation was so small as to promise little value in identifying potentially successful students.
3. The (ACT) mathematics score and the technical courses (GPA) score was found to have the highest correlation coefficient (0.406) and a confidence level of 0.0083.

On the basis of these results one could conclude that (ACT) mathematics would offer the most promise as a tool for identifying potentially successful students for electromechanical technology. However, since even the strongest correlation found was small, it would offer little promise of actually predicting student success.

Discussion of Results

To select potentially successful students for an educational program by use of statistical correlations can be argued at great length. Some authorities contend that correlations are descriptive statistics functioning only to

describe the existing state of relationship between two sets of scores. If this view is taken then a correlation may not be used as a predictor. This being the case, correlation coefficients may not be employed in selecting potentially successful students.

Other authorities (23), perhaps a majority, hold that when correlation coefficients are coupled with an evaluation of the level of statistical significance they become inferential quantities and may be used as predictors.

Based on the view that correlation coefficients may be considered predictors when they are statistically significant, the following interpretations of the results of this study can be made.

The Kendall rank correlation coefficients representing the relationships between the general education (GPA), cumulative (GPA) scores and student (ACT) composite score were all below 0.1 and were not statistically significant. The actual correlation coefficients for these two tests were 0.098 and 0.007 respectively. The levels of significance for the two coefficients were 0.0188 and 0.401 respectively. The low values of the correlation coefficients would seem to indicate that these variables could not be used effectively in identifying promising potential students for electromechanical technology. The scatter diagrams given in Figures 2 and 3 tend to confirm this contention. Moreover, the significance level of one indicates that there was a possibility of over 40 percent that the correlation coefficient

observed was due to chance alone. On this basis the null hypotheses dealing with these two variables could not be rejected.

The observed coefficient of correlation for the relationship between the math-and-science (GPA) scores and the (ACT) math scores was 0.23. The level of statistical significance of this correlation was 0.117. In many instances the null hypothesis concerning this relationship could be rejected. However, in this study this particular hypothesis was not rejected because the coefficient was relatively low. The scatter diagram, Figure 1, would seem to indicate that this variable would have very limited value as a means of identifying promising potential students for electromechanical technology.

In the case of the technical courses (GPA) the scores correlated with (ACT) mathematics scores to the extent of producing a Kendall rank correlation coefficient of 0.115 at the 0.0009 confidence level. On the basis of these values, the null hypothesis associated with this variable could be rejected. An examination of the scatter diagram, Figure 5, reveals that this variable would probably have only limited value in identifying promising potential students for electromechanical technology.

The Kendall rank correlation coefficient for the relationship between technical courses (GPA) and (ACT) mathematics was the highest revealed by this study. The coefficient value of 0.406 was significant at the 0.0083 level.

Consequently, the null hypothesis associated with this variable could be rejected. Of the five variables considered in this study, this one (ACT) mathematics score would seem to provide the strongest basis for selecting promising potential students for electromechanical technology. The distribution of the data points in the scatter diagram for this variable, Figure 4, tends to confirm this conclusion in that there is less spread in the independent variable values for a given dependent variable value than is observed for any of the other correlations.

Conclusions

The results of this study should be of some value in selecting entry students for a program in electromechanical technology. It should not, however, be implied that the variables in this study are the only factors to be considered in identifying promising potential students. Nor, is it necessary that identical results are to be expected if the study is repeated under different conditions.

Perhaps the greatest significance of the study lies in the fact that it demonstrates that the factors which are useful in identifying promising potential students for the technological areas may not be the same as those used in other areas of education.

Recommendations

A number of investigations of this type have been

conducted comparing American College Test scores and student achievement. The results of this study and those reviewed in Chapter II are in good general agreement. Consequently two recommendations would seem to be in order.

1. The correlation between (ACT) scores and student (GPA) has been consistently found to be either very small or statistically insignificant. It is therefore recommended that (ACT) scores not be used to predict student success.
2. Because there has been good agreement between various studies of this type, it is recommended that further research into the correlation between (ACT) scores and student (GPA) is probably not needed.

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APPENDIX

DATA

Rank	(ACT) Math	(ACT) Comp.	(GPA) Math and Science	(GPA) Tech	(GPA) Gen. Ed.	(GPA) Cum.
1	7	7	7	7	5	8
2	5	2,14	5,8	8	8	7
3	11			11	11	11
4		8,9	11	5,6	10	5
5	9,10				16	3
6			3,6,10	3	1,15	6
7		1,10,16		10		10
8	2		15	9		15
9	4,8	3,12	2	2	3,4,6,7	13
10			13	1,15		2
11	3	5	9			16
12		4,13	1	14	2,13	1
13	1,13,15,16		14	4		9
14		11,15			12	4
15			4,12,16	12,13,16	9,14	14
16	6	6				12

The numbers entered in the rank rows are those which identify individual subjects.

VITA²

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Candidate for the Degree of
Master of Science

Thesis: STUDENT ACHIEVEMENT IN ELECTROMECHANICAL TECHNOLOGY

Major Field: Technical Education

Biographical:

Personal Data: Born in Oklahoma City, January 29,
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Education: Graduated from high school in Midwest City,
Oklahoma in 1965; graduated from Oscar Rose Junior
College in 1972 with an Associate Degree in Elec-
tromechanical Technology; received a Bachelor of
Science from Oklahoma State University in 1974
with a major in Technical Education.

Professional Experience: Employed by Oscar Rose Junior
College part-time from 1970 to 1972; during 1974
was employed by Black and Veatch in Kansas City,
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Power Division.